

EMERGENCY VEHICLE OPERATOR

Module 2
Major Vehicle Systems
Pre-trip Inspections



OBJECTIVES



- Identify the major vehicle systems and their component parts
- Determine methods and requirements for pre-trip inspection of vehicle systems
- Define maintenance requirements for vehicle systems
- Review MCFRS out-of-service criteria for fire department apparatus
- Review defect reporting and resources for apparatus operators



MOTIVATION

WHY KNOW THE COMPONENTS?

- Correctly identify defects and write accurate defect reports
- Determine and differentiate between normal, monitoring, and out of service conditions
- Identify critical safety issues before they cause injury or damage
- Ability to communicate with mechanics when describing conditions – “speaking their language”
- Make educated decisions about the vehicle you are driving!

DEFINITIONS

MCFRS OOS CRITERIA



- Leakage
 - Class 1: seepage of fluid; not enough to form drops
 - Class 2: leakage great enough to form drops; drops do not drip
 - Class 3: leakage great enough for drops to drip
- Operational Test: A test to determine the operational readiness of a component on a fire apparatus by observing the actual operation of the component.

VEHICLE SYSTEMS



VEHICLE DATA PLATE

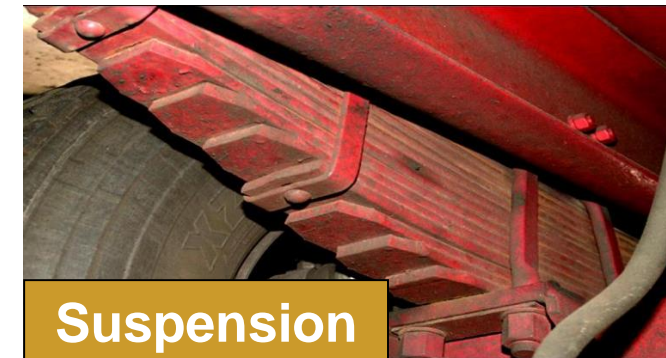
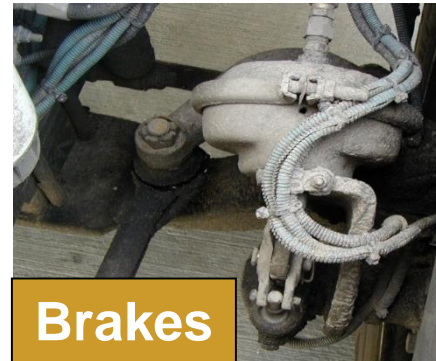
- Each apparatus should have a manufacturer's data plate in the cab
- Information may differ from the information found on the chassis data plate on the door frame
 - Manufacturer's data plate reflects final completed "as built" vehicle
 - Chassis data plate reflects just the chassis information prior to body installation or customization
- Use the manufacturer's plate as the reference for the finished vehicle

ITEM/TYPE	CAPACITY	LUBRICANT
Diesel Fuel	40 Gallons	Diesel Fuel
Diesel Exhaust Fluid	6 Gallons	DEF
Engine Oil	20 Qts	15w40
Coolant	11 Gallons	Extended Life Red
Transmission Fluid	10.6 Qts	Transynd
Rear Axle	8 Qts	Synthetic 75-90
Power Steering Fluid	5 Qts	Dextron III
Brake Fluid	5 Pints	DOT 3
Refrigerant Oil Front	2.88 Lbs	R-134-A
Refrigerant Oil Front	2.88 Lbs	PAG-Denso ND-8
AC Refrigerant Rear	2.5 Lbs	R134-A
Refrigerant Oil Rear	7 OZ	PAG-46
Overall Length	27 Feet	
Overall Width	9 Feet 6 Inches	Mirror to Mirror
Overall Height	9 Feet 6 Inches	
Front Tire Pressure	95 PSI	
Rear Tire Pressure	85 PSI	

FIVE MAJOR SYSTEMS

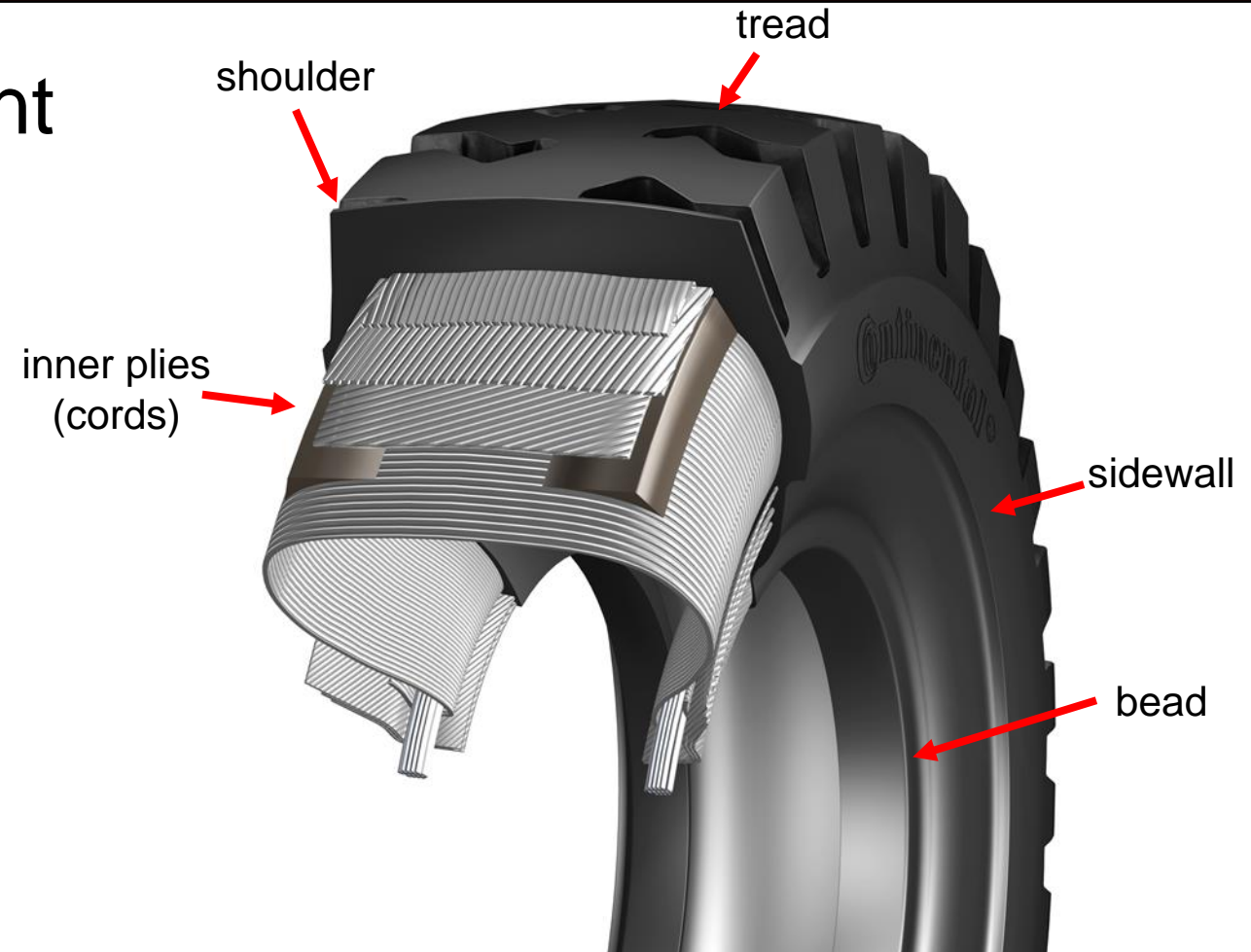
There are five primary vehicle systems that impact your ability to safely control the apparatus:

1. Tires
2. Wheels
3. Steering
4. Suspension
5. Brakes



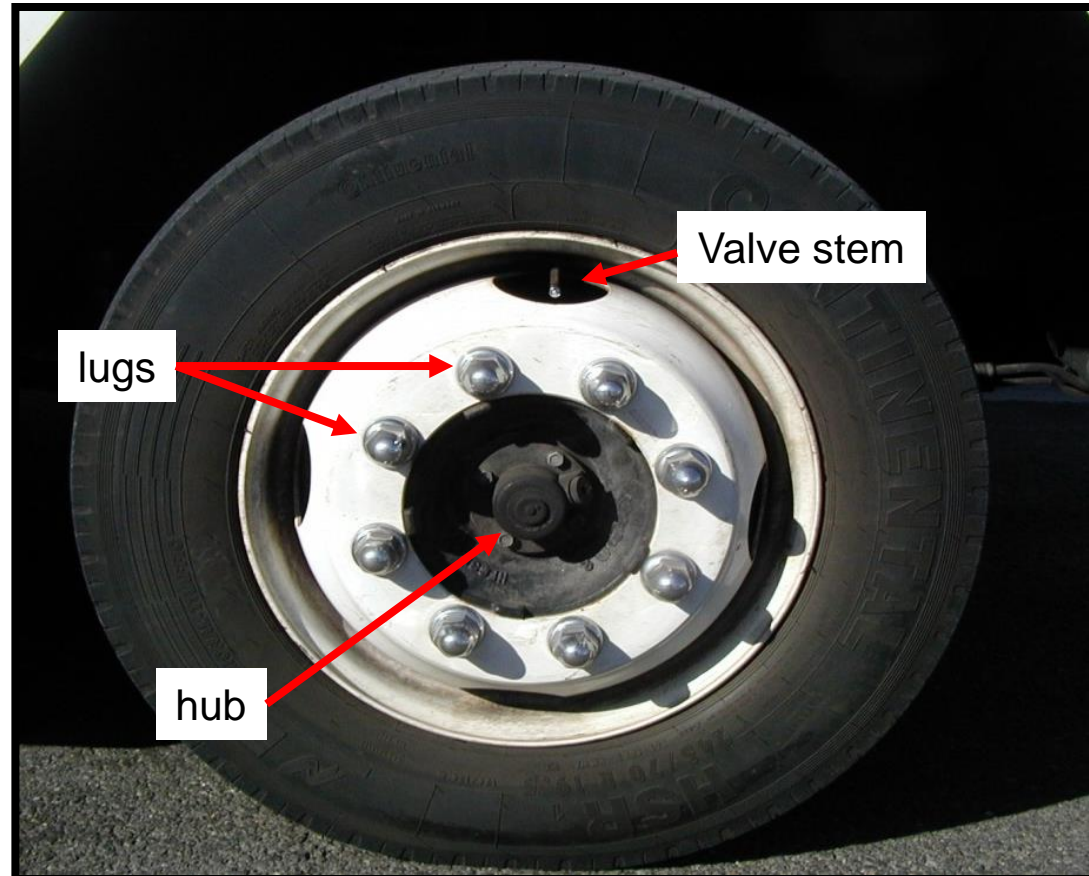
TIRES

- Key to all vehicle movement
 - Steering
 - Braking
 - Accelerating
- CID
 - Condition
 - Inflation
 - Depth



WHEELS

ALUMINUM OR STEEL



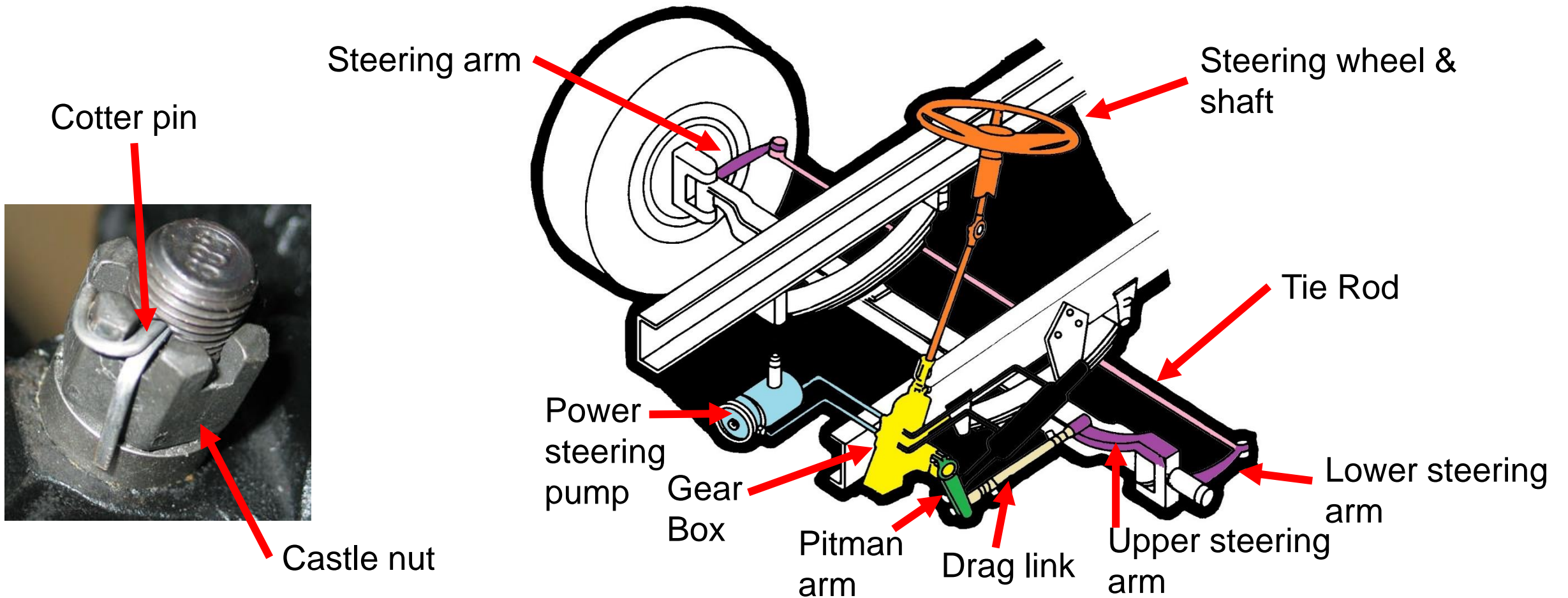
WHEELS

AESTHETIC COVERS

- Economical alternative to aluminum wheels
- Covers installed over steel wheels or old aluminum wheels
 - Hook onto hand holds
- Covers bear **NONE** of the load
- Hide corrosion, damage, leaking hubs, or defects in the load-bearing component of the wheel
- Obscures hub oil window

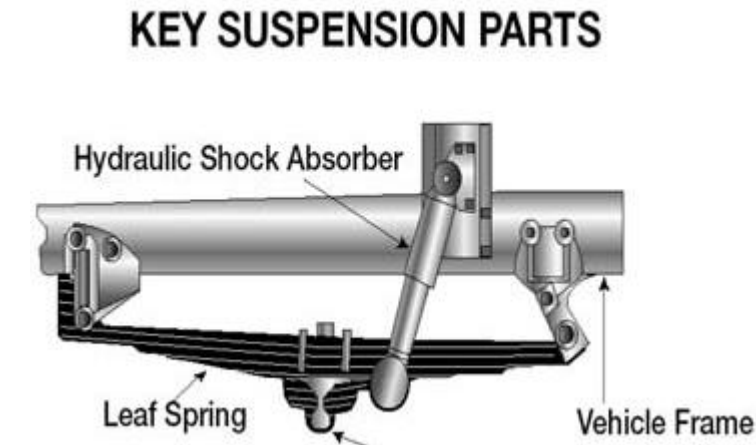


STEERING SYSTEM

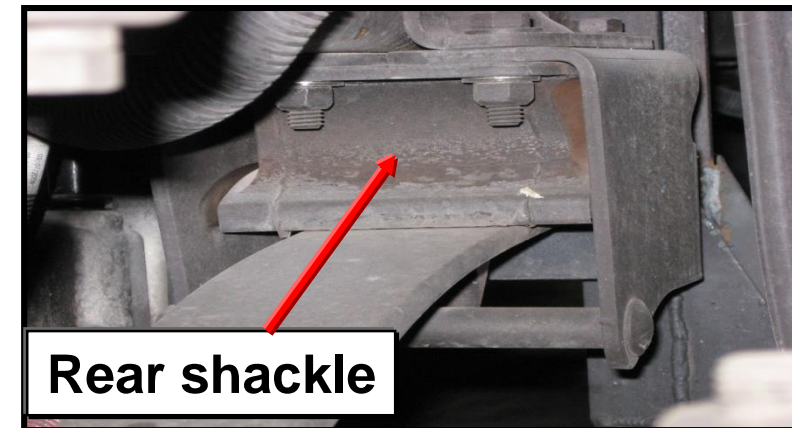
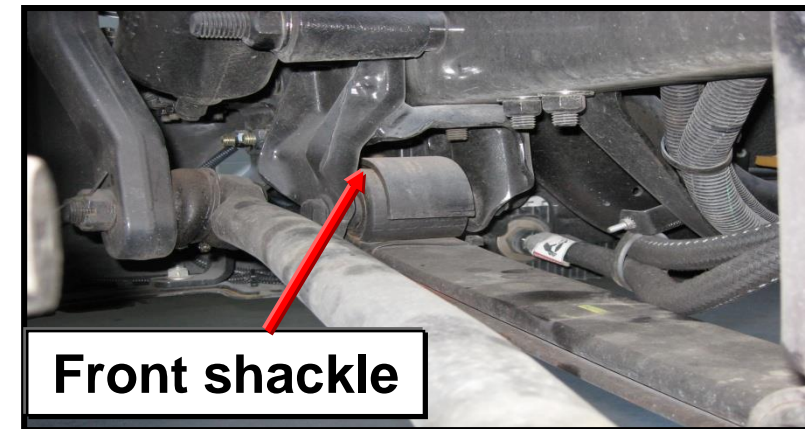
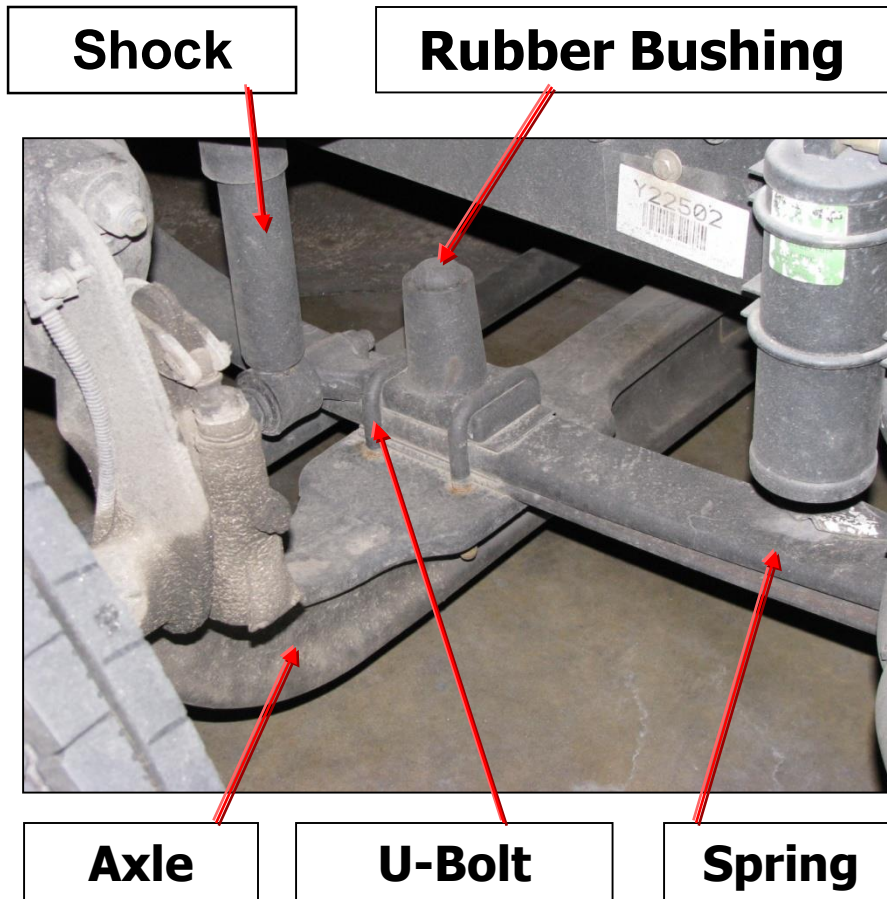


SUSPENSION

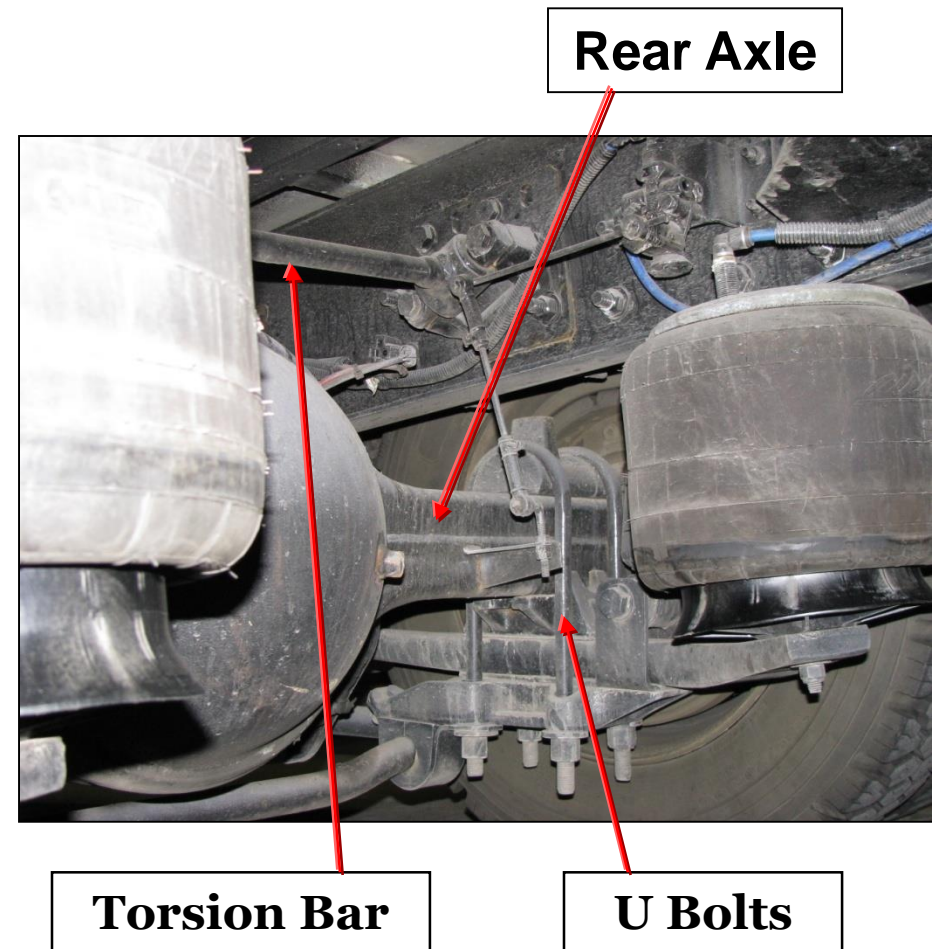
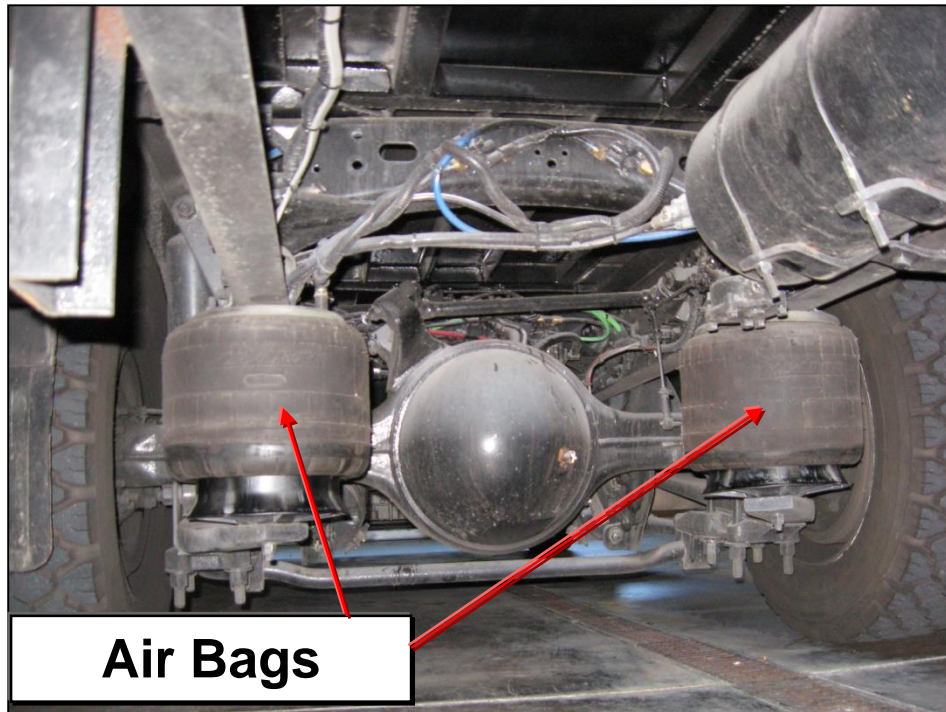
- Everything that connects the body and accessories to the wheels
 - Frame
 - Body mounts
 - Springs
 - Shock absorbers
 - Axles
- Enables the vehicle to adjust to imperfect travel surfaces
 - Improves handling
 - Improves passenger comfort
 - Reduces wear on the body and accessories
 - Constantly under stress and load



FRONT SUSPENSION



REAR SUSPENSION



SUSPENSION WEIGHT RATINGS

- Gross Vehicle Weight Rating (GVWR)
 - includes curb weight, additional equipment that's been added, the weight of cargo and the weight of passengers
 - Maximum total weight vehicle may ever be
- Curb Weight
 - Includes all vehicle components without passengers or cargo



20,000lb
Axle weight
rating

27,000lb
Axle weight
rating



BRAKE SYSTEMS

- Generate friction at the wheels to slow or stop the vehicle
- May be hydraulic or air on EMS Units
- Anti-lock braking systems have additional electronic sensors that control the air or hydraulic system
 - If ABS fails, the brake system reverts to a traditional friction system
- Friction at the wheels is generated by drum or disc style brakes



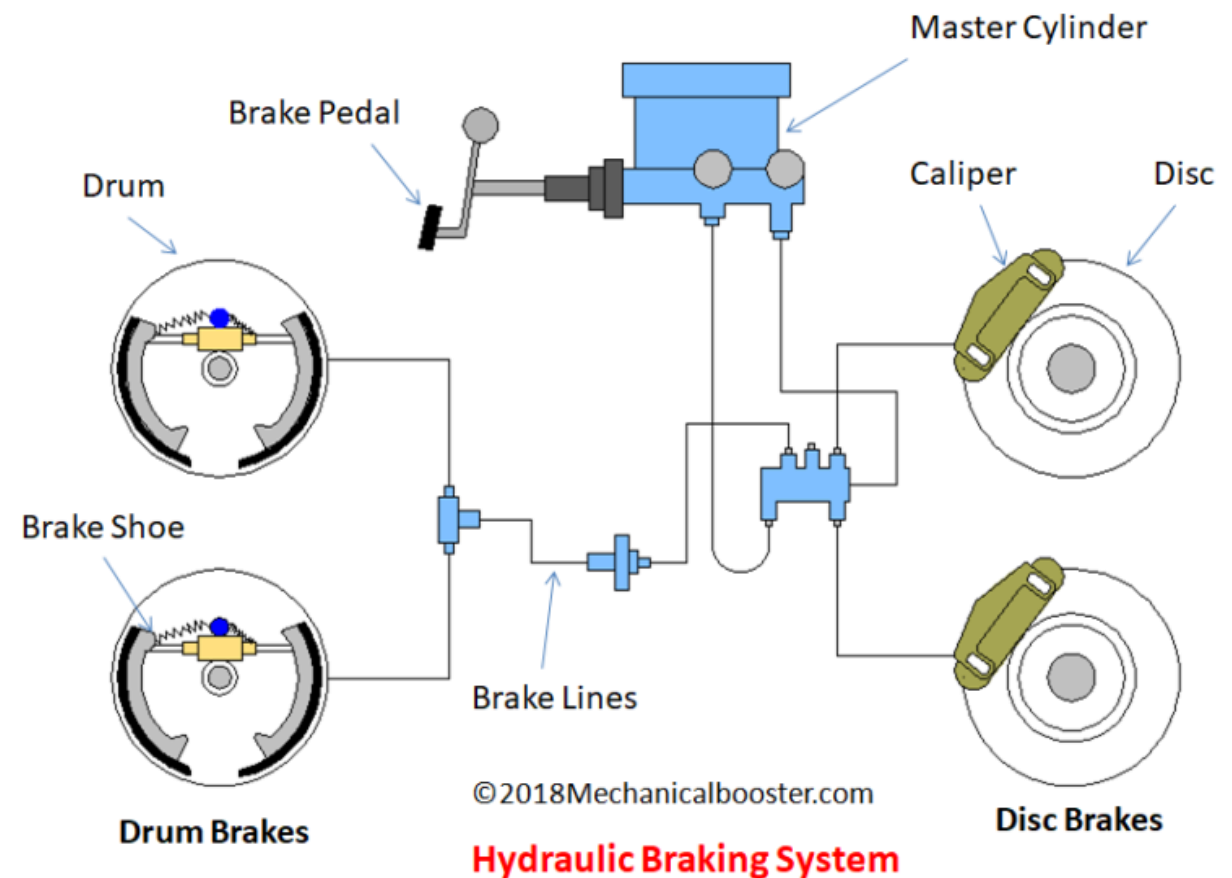
ANTI-LOCK BRAKING SYSTEMS

- **Electronic Control Unit:** the brain of the ABS
 - Controls the air pressure to the brake chamber via the modulation valve
- **Exciter or Pulse Ring:** attached to the axle or wheel hub turning at the same speed as the wheel
- **Wheel Speed Sensor:** a small induction coil mounted in close proximity to the pulse ring
 - Generates an impulse to the electronic control unit, which determines the speed at which each wheel is turning.
- **Modulation Valves:** control air pressure to the brake chambers on command from the electronic control unit
 - As quickly as 5 times per second - apply, release, or hold air pressure

BRAKE SYSTEMS

HYDRAULIC

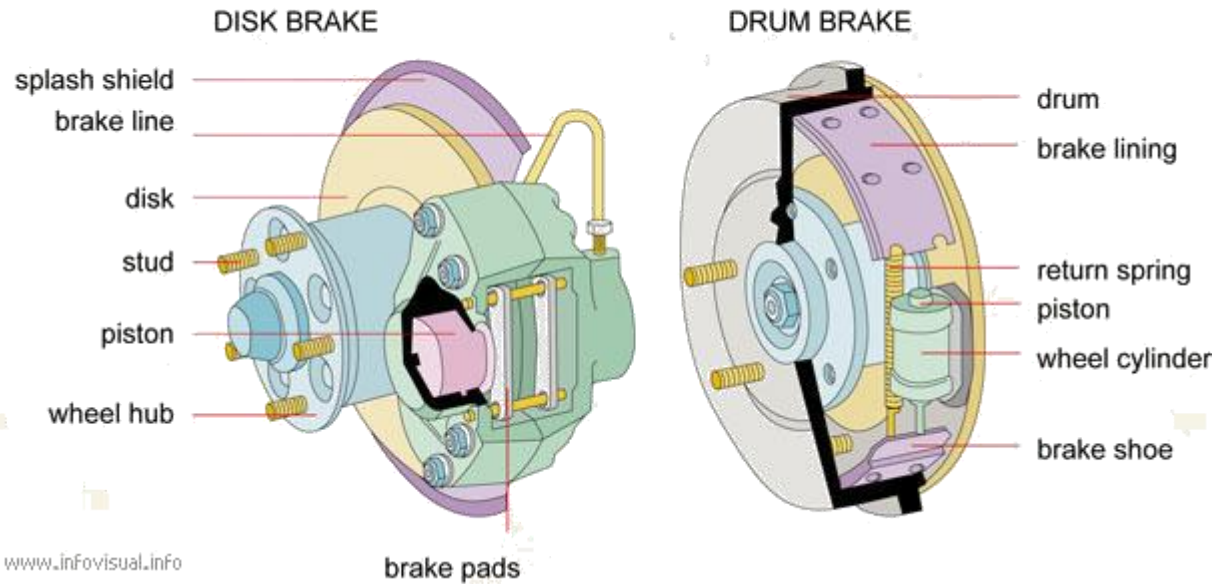
- Hydraulic systems use fluid to translate pressure from the brake pedal to the brakes at the wheels
- Master cylinder converts mechanical pressure of the brake pedal into hydraulic pressure



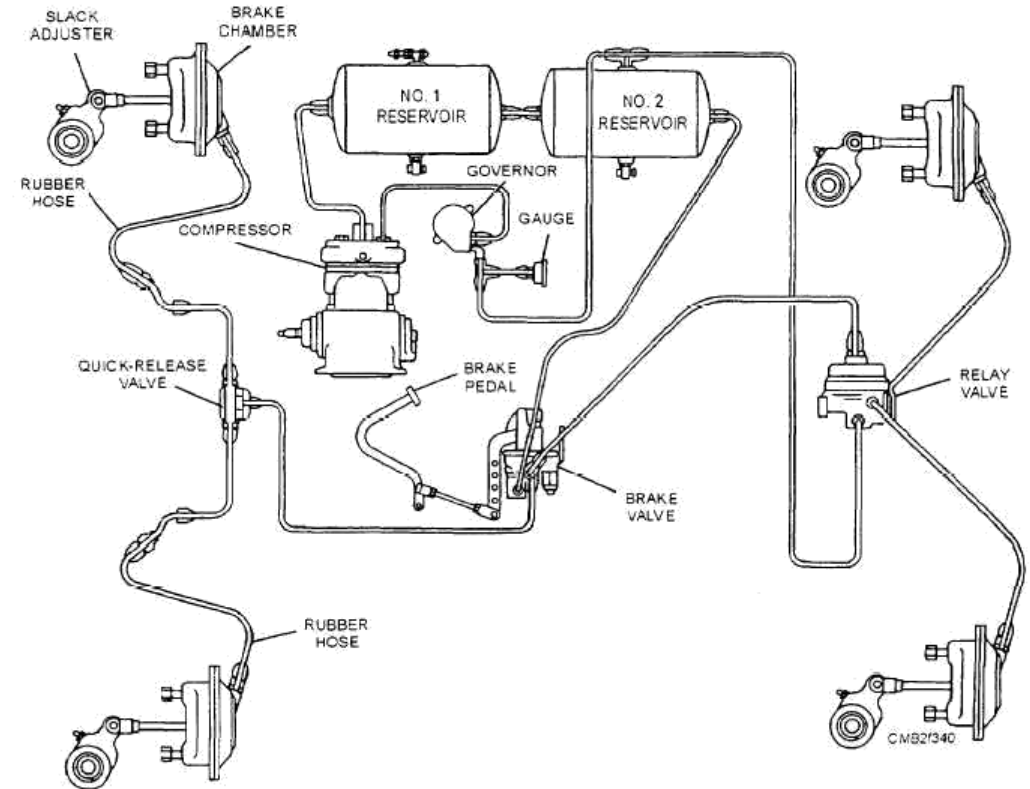
BRAKE SYSTEMS

AIR

TYPES OF BRAKES



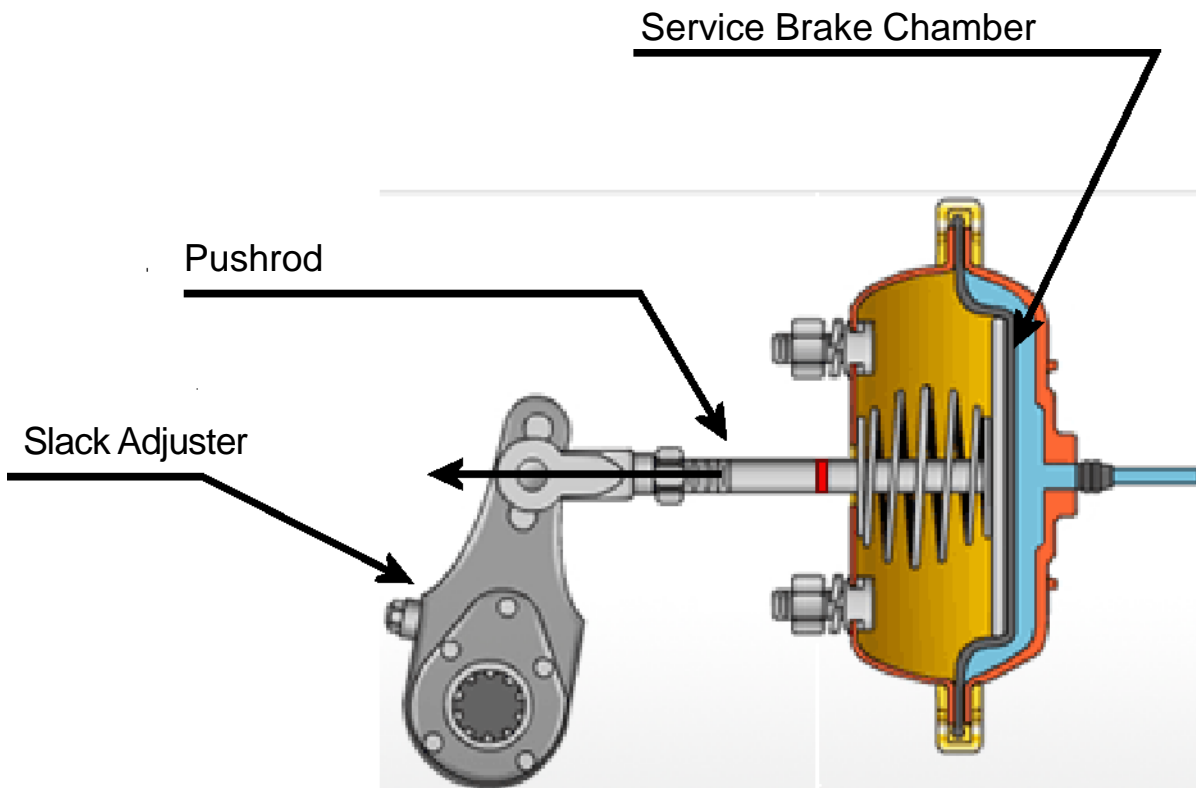
*Note: these diagrams are for hydraulic brakes, but the systems are similar to air brakes



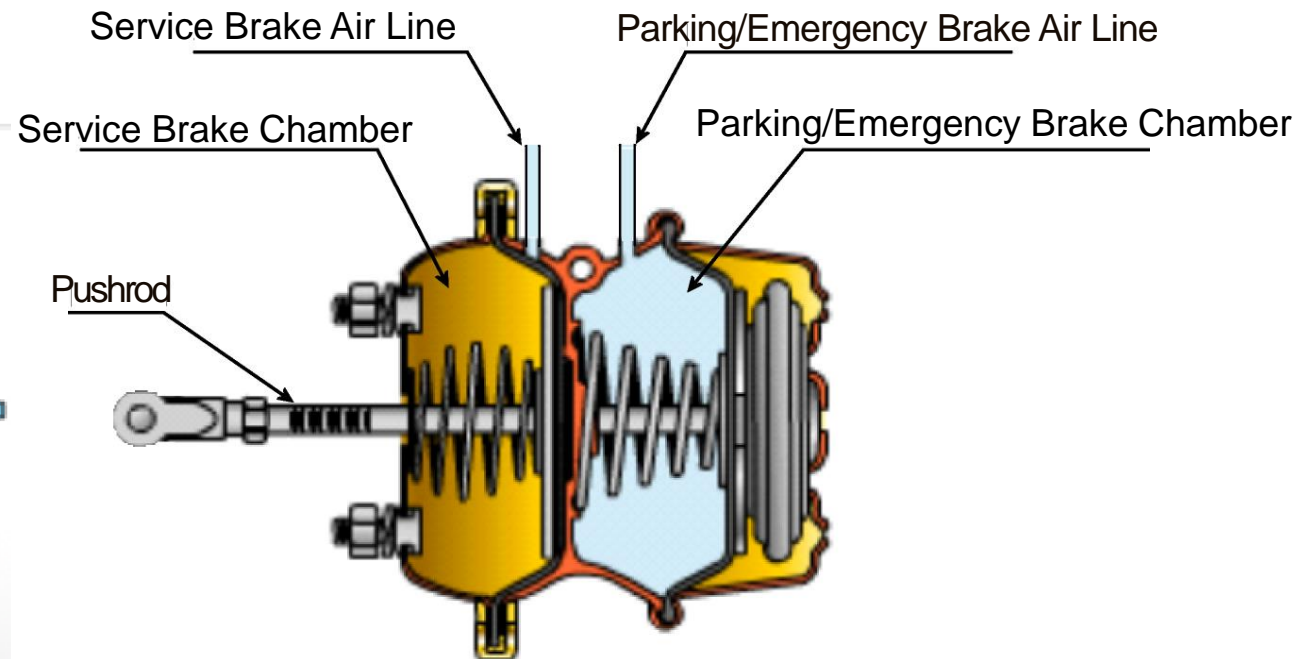
[Air Brake System Video](#)

AIR BRAKE SYSTEM COMPONENTS

Single Chamber



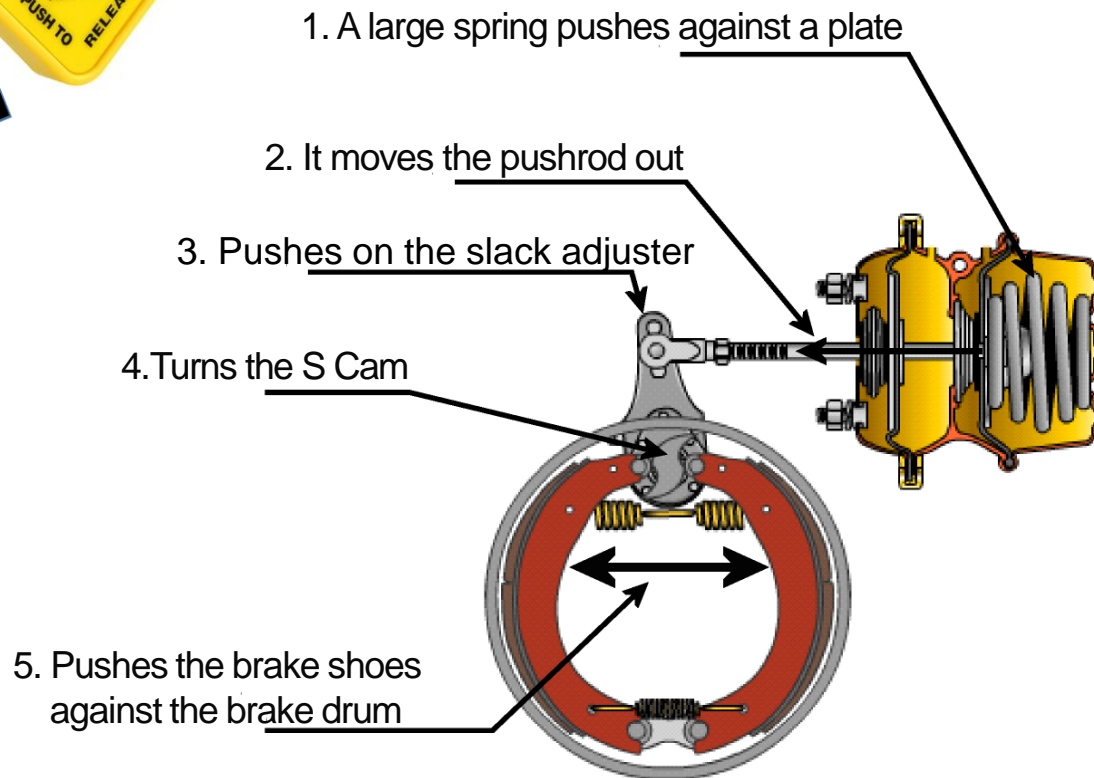
Dual Chamber



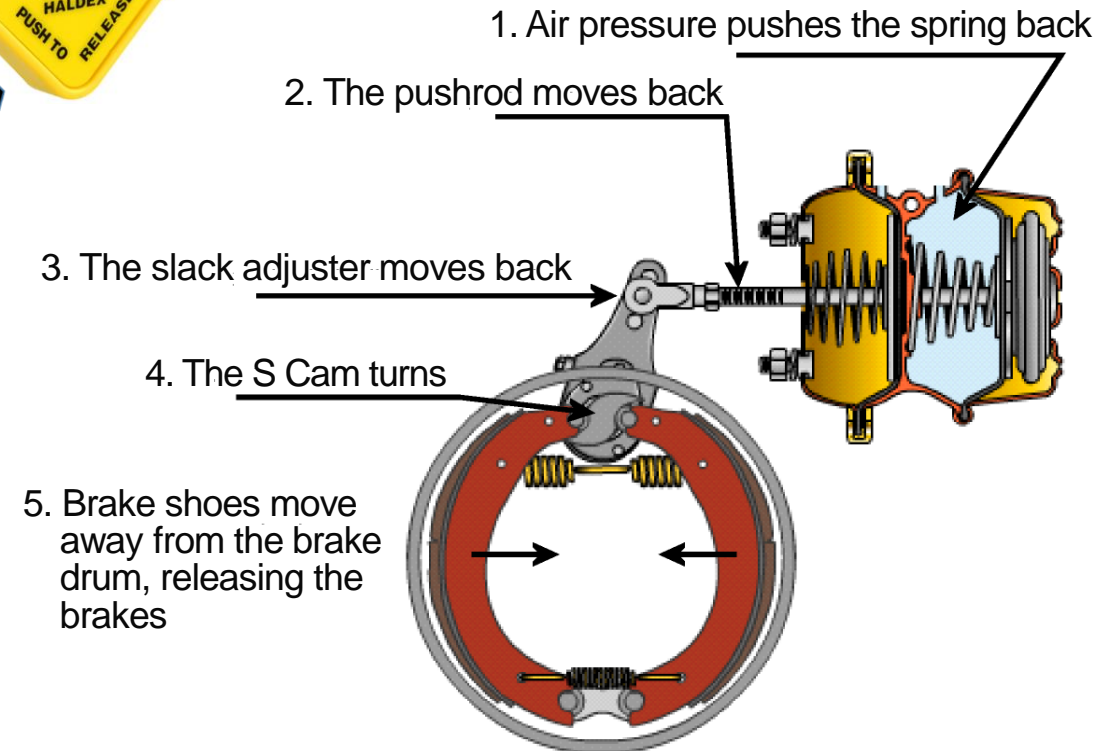
AIR BRAKES

PARKING – SPRING BRAKE

Parking Brake Applied



Parking Brake Released

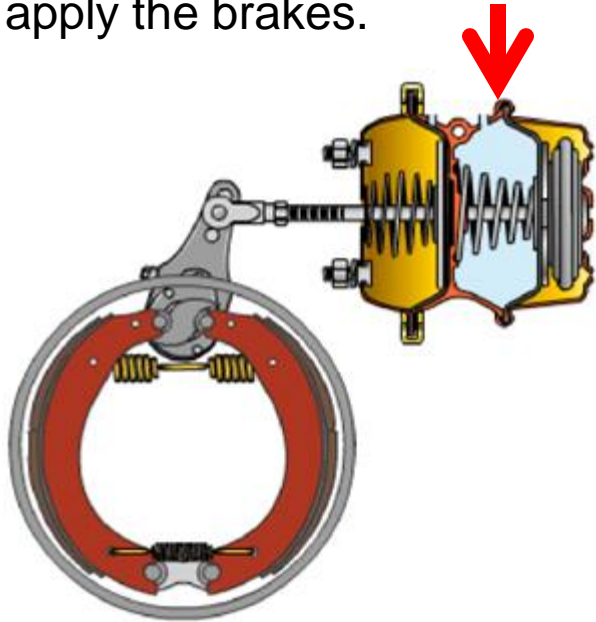


AIR BRAKES

TRAVEL – SERVICE BRAKE

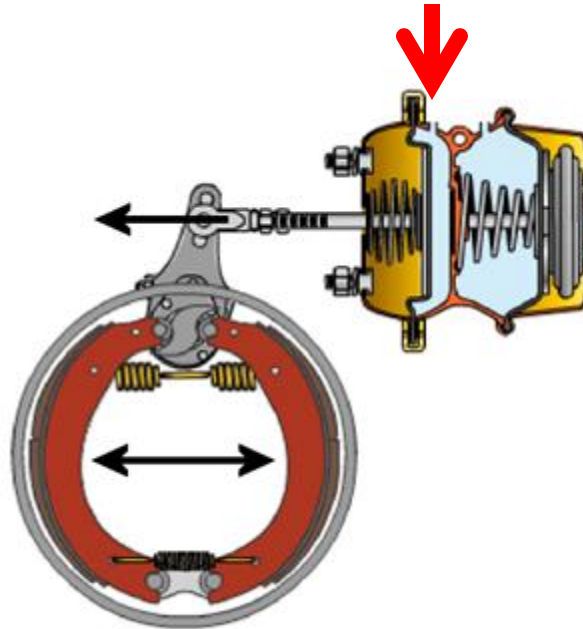
Accelerating or Coasting

Air pressure disengages the parking/ emergency brake, so the wheels can turn. If air pressure is lost in this chamber, the spring will apply the brakes.



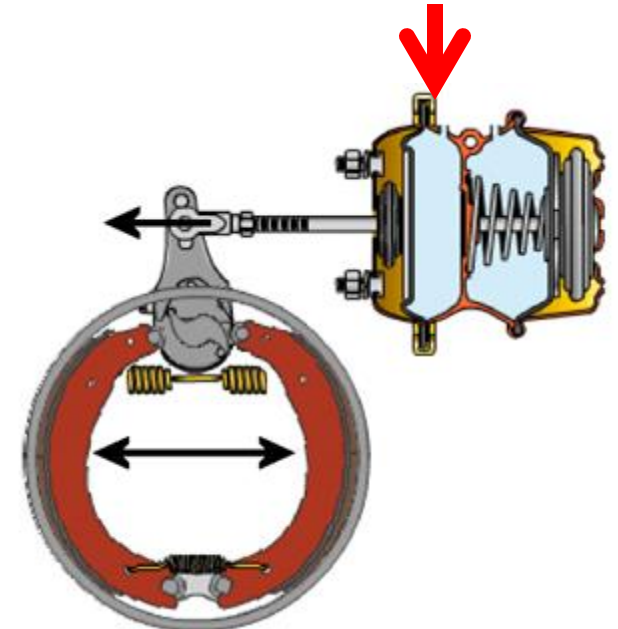
Braking – Lag/Reaction Time

The brake pedal is pushed and air is forced into the service side brake chamber. The pushrod moves out, turning the slack adjuster and S cam.

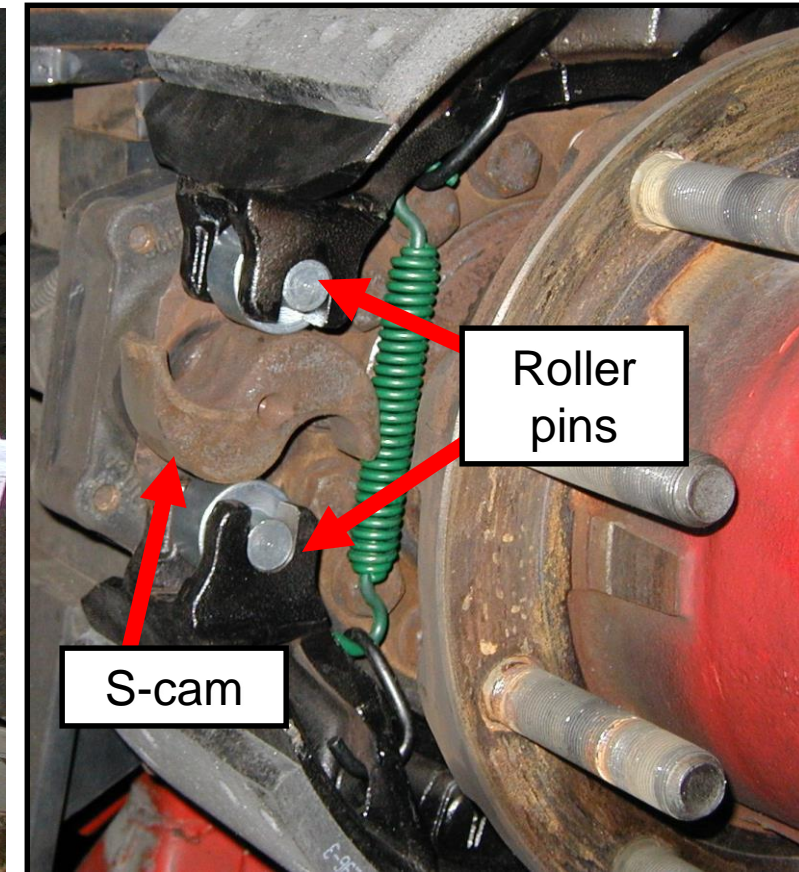
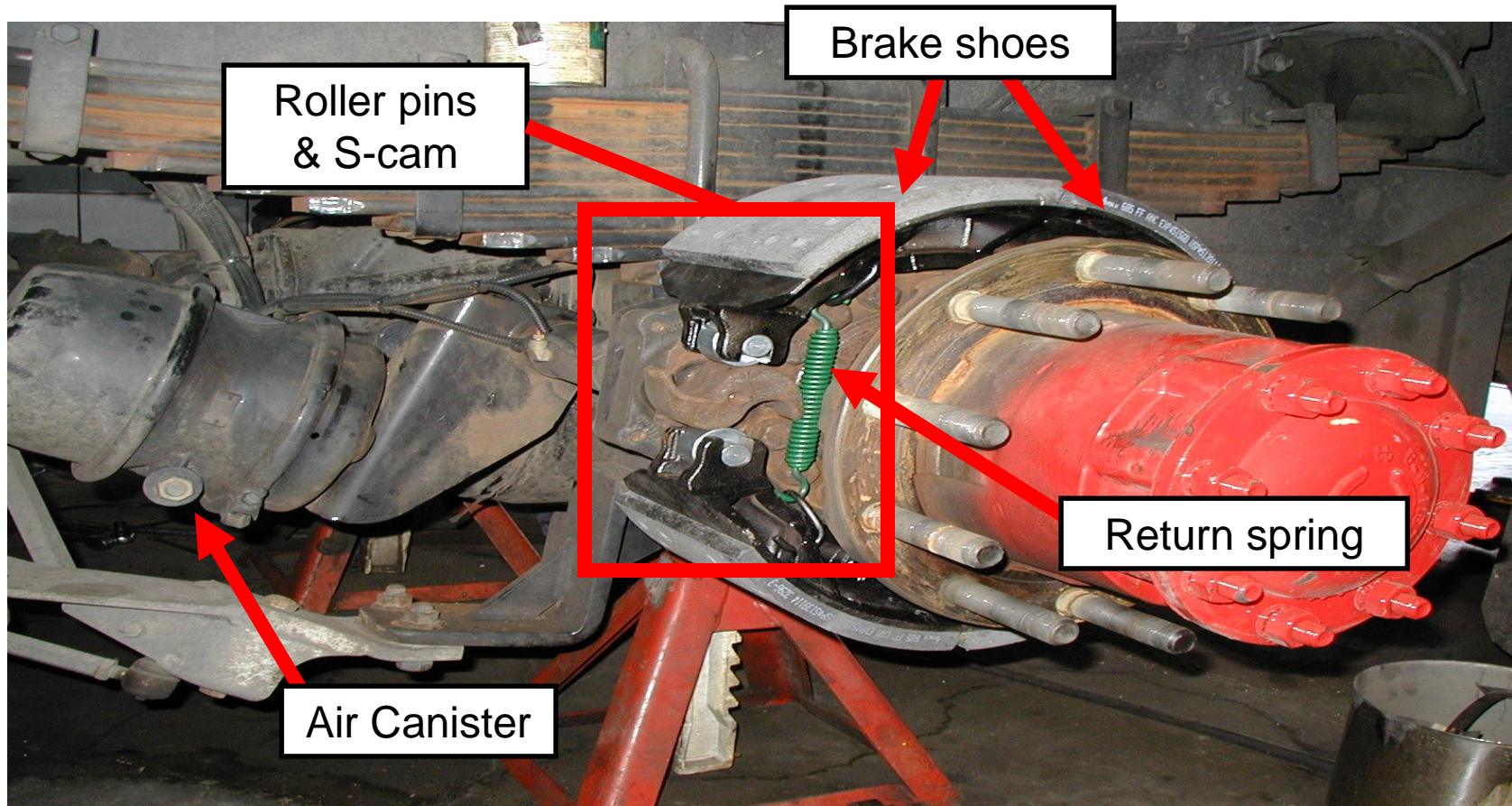


Braking – Slowing/Stopping

The brake shoes are pushed against the brake drums causing the truck to slow.



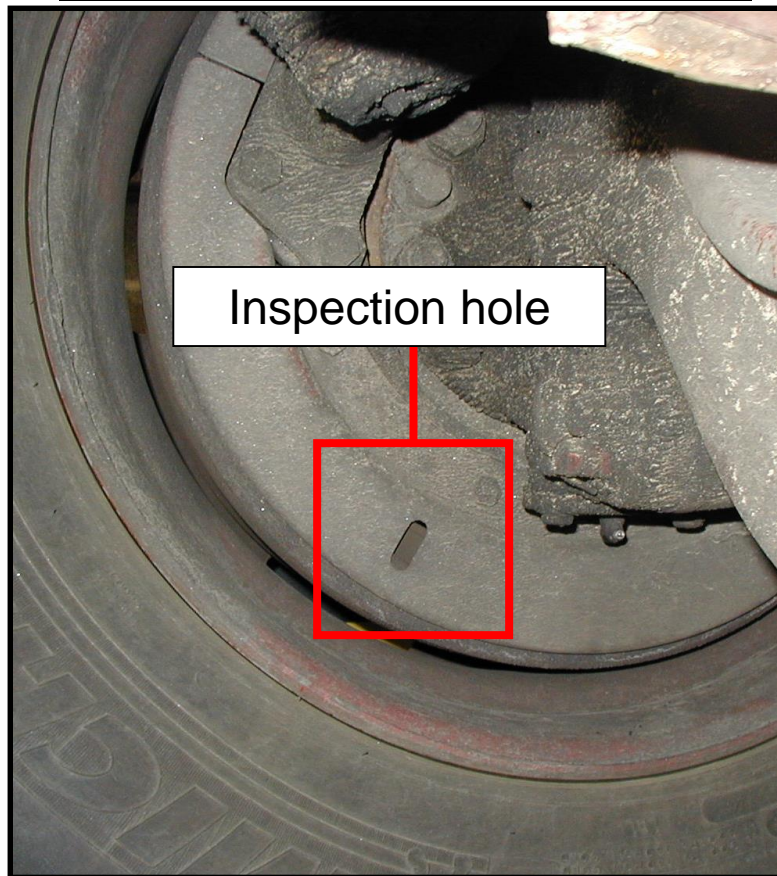
DRUM BRAKES COMPONENTS



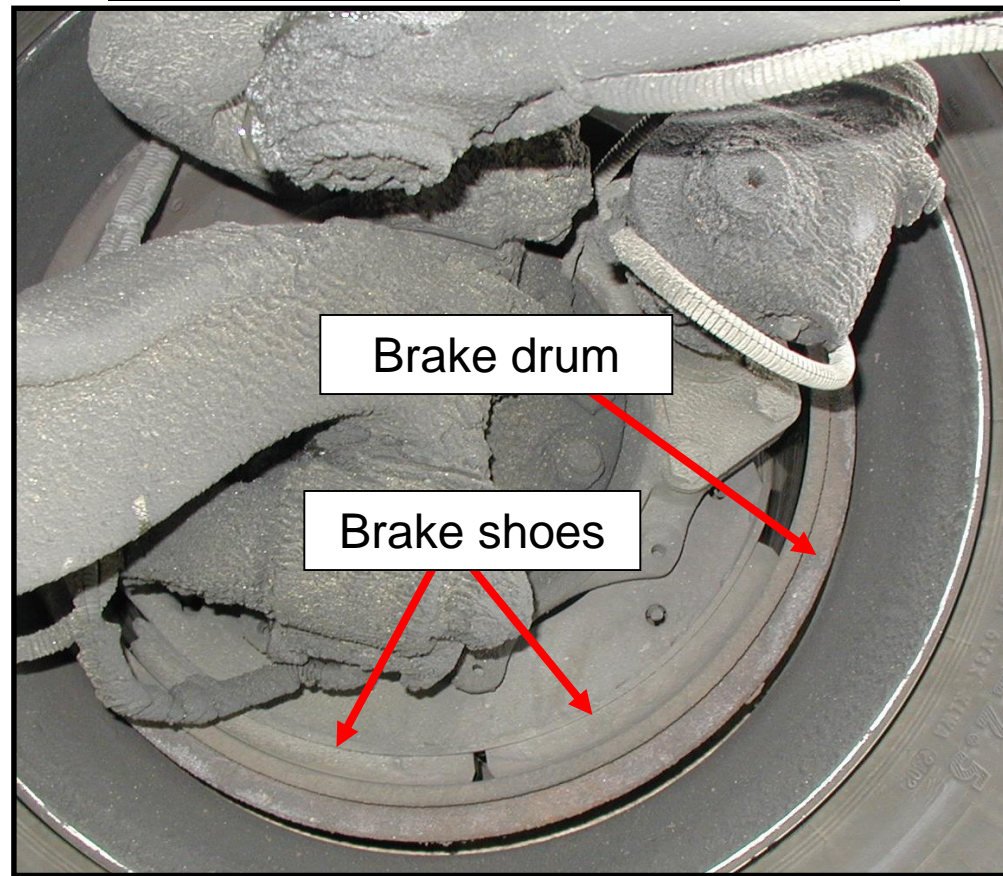
DRUM BRAKES

BRAKE SHOE INSPECTION

Wheel with Dust Cover



Wheel without Dust Cover



AIR BRAKES

DOT INSPECTION



- Conducted in a specific sequence
 - Ensures all critical features are checked properly
- Incorrect sequence
 - Does not check operation of the system sufficiently
 - Will result in a failure during candidate exams - PAGES
- Requires a watch, phone, or other means to keep time
- Park on reasonably flat ground
- Place wheel chocks on both sides of a wheel
- Battery and ignition switches must be on for gauges and warning devices to operate

AIR BRAKES

C-O-L-A



C=Cut in Pressure

- Indicates compressor is engaging properly
 - Motor running and fanning the service brake
 - Storage pressure drops until compressor engages **>95psi**
 - Cut-in pressure of **<80psi** is OOS criteria

O=Cut out Pressure

- Indicates governor is working properly and compressor is disengaging properly
 - Motor running and storage tank pressure rising
 - Compressor shuts off between **120** and **135psi**
 - Listen for the air dryer to exhaust air
 - Cut-out pressure of **>135psi** is OOS criteria

AIR BRAKES

C-O-L-A



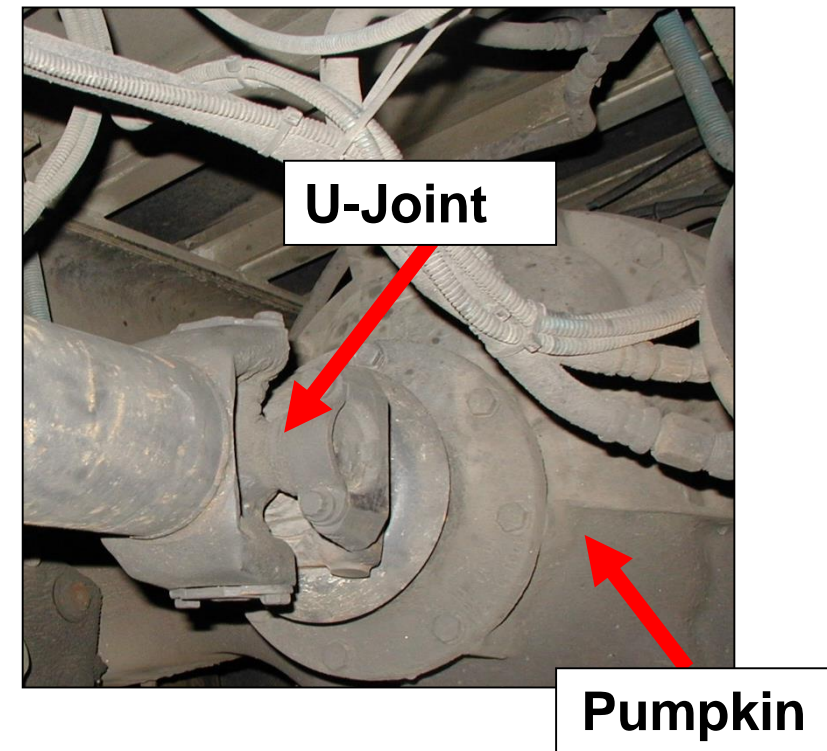
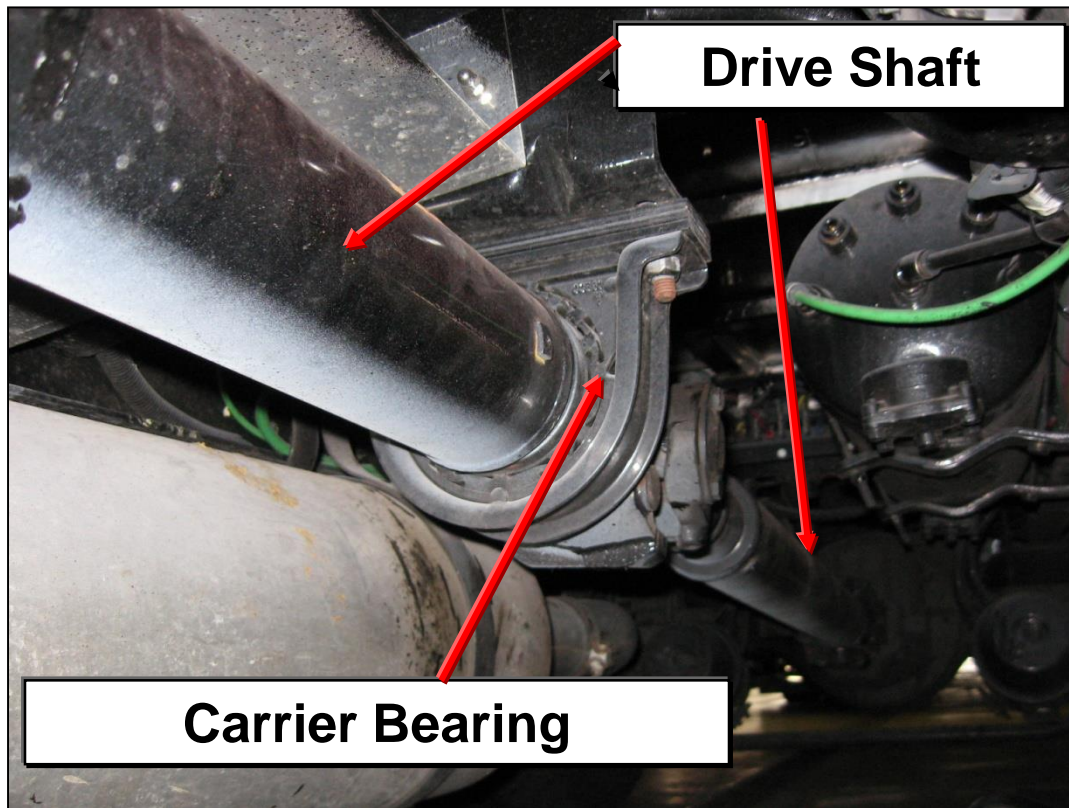
L=Low Pressure warning

- Verifying that the low air alarms are functioning
 - Motor shut down but ignition on
 - Fan the service brakes to bleed storage tanks
 - Low air visual and audible alarms should engage **60** to **90**psi
 - Alarms that do not engage **<60psi** are an OOS criteria

A=Air Leakage rate

- Assessing the ability of the entire system to hold air
 - Motor shut down
 - Monitor storage air levels for 1 minute
 - Levels should drop **<3**psi; or **<4**psi for tractor drawn vehicles

DRIVELINE



PRE-TRIP INSPECTION





PRE-TRIP INSPECTION

1. Review defect records
2. Vehicle overview
3. Walk around check
4. Engine compartment
5. Interior cab
6. Undercarriage check
7. Compartment equipment check
8. Motor started/operations check
9. Complete documentation



PREPARATION

- Pass along from prior shift
- Obtain pre-trip equipment
 - Creeper, flashlight, rag or paper towel, note pad
 - Eye protection, gloves
- Circle check
- Has the unit recently been run?
 - Beware hot components
- Determine a suitable location
- Wheel chock placed



ENGINE COMPARTMENT

- Hood cables
- Radiator & Overflow
- Alternator
- Air conditioner compressor(s)
- Air filter & restriction gauge
- Fan
- Belts & Hoses
- Power steering pump
- Air compressor
- Steering shaft, box, linkage
- Lower steering components
- Front suspension
- Fluids
 - Motor oil
 - Transmission fluid
 - Power steering fluid
 - Coolant



OOS CRITERIA – ENGINE COMPT

- Air filter restriction indicator that shows maximum restriction after resetting
- Engine system that has significant leakage of oil
- Oil that contains coolant
- Oil that is diluted with fuel
- A fuel system component that has Class 2 leakage of fuel
- Cooling system component that has Class 3 leakage
- Coolant that contains oil
- Radiator that is loose
- Cooling fan that is loose or cracked
- Transmission fluid that contains engine coolant



INTERIOR CAB

- Instrument Panel
- Accelerator
- Conduct Air Brake Test
- Check Steering Wheel
- Seat, mirror, and steering wheel adjustment
- Switch panels
- Automatic snow chains
- Transmission fluid
- Windshield
- Heat / air conditioning
- Defroster
- Radio/Computer Equipment
- Interior/Exterior Lighting
- Mirrors
- Occupant Restraints
- Vehicle registration and insurance card
- DOT inspection certificate

TRANSMISSION SELECTOR

- All frontline apparatus have automatic transmissions
 - Park in “N”
 - Pull the parking brake
- Generally no reason to use the up/down arrows during travel





OOS CRITERIA – INTERIOR CAB

- Defective or damaged driver's or officer's seatbelt
 - Must be enough functioning belts for each crew member
- Cracked or broken windshield that obstructs the driver's/operator's view
- Missing or broken mirrors that obstruct the driver's/operator's view
- Windshield wipers that are missing or inoperable
- Steering wheel that has a deficiency affecting the drivability of the vehicle
- Door latches that are defective
- Defrosters that are inoperable
- Accelerator that is inoperable or defective
- Oil pressure, engine, and/or transmission temperatures that can not be monitored or verified
- Engine or Transmission that is overheating
- "Stop-engine" warning light that remains illuminated after engine is started
- Speedometer that is inoperable



OOS CRITERIA – INTERIOR CAB

- Automatic transmission that has a “Do not shift” light on
- Charging system that fails to maintain 12-volts
- Air gauge or audio low air warning device that has failed or is inoperable when air pressure < 60psi (vehicles with air brakes)
- ABS warning indicator that is activated. (The warning indicator generally indicates that ABS is inoperable and the vehicle should be driven as such.)
- Brake warning light that is activated or brake pedal that falls away or drifts toward the flooring when brake pressure is applied
- No operable audible DOT warning devices (at least either the electric horn or the air horn, if so equipped, must be operable)
- No operable audible emergency warning devices (at least the electronic siren, or the mechanical siren, if so equipped, must be operable)



UNDERCARRIAGE

- Bleed Moisture From Air Tanks/ Air Brake Systems
- Brake System
- Driveline
- Exhaust System
- Suspension System
- Automatic Chain Systems
- Leaks From Transmission or Axle
- Body mounts
- Rust
- Loose Parts
- Shiny Spots, Cracks
- Inner Sides of Tires and Wheels
- Wiring Harness
- Loose Belts & Hoses
- Fuel Tank



OOS CRITERIA - UNDERCARRIAGE

- Defective body or cab mounts
- Defective suspension components
- Steering components that are defective affecting the vehicle handling
- A steering component that has Class 3 leakage
- Driveline components that are defective
- Axle flanges that have Class 3 leakage
- Exhaust components are broken or hanging
- Exhaust components are that leaking causing exhaust fumes to enter the cab or patient compartment



OOS CRITERIA - UNDERCARRIAGE

- Tires that have cuts in the sidewall that penetrate to the cord
- Any tire that is flat or has a detectable or audible leak
- On dual wheel tires: tires that are touching sidewall to sidewall when properly inflated
- Wheels that are cracked, bent, and/or broken that affect drivability
- Fuel tank, mountings, or straps that are defective
- Transmission components that have Class 3 leakage of transmission oil
- Braking system components that are defective
- Brake system components that have Class 2 leakage of brake fluid
- Friction surfaces, brake shoes, or disc brake pads that have grease or oil on them



EXTERIOR BODY & COMPARTMENTS

- Battery box & Batteries
- Fuel Tank
- DEF tank
- Shoreline connection
- DOT lights
- Warning lights
- Tires and wheels
- Exhaust pipe
- Compartment latching
- Inventory
- Spare electrical fuses
- Flares or warning triangles
- Wheel chock
- PPE
- SCBA
- Specialty equipment
- Fire extinguisher



OOS CRITERIA – EXTERIOR

- Door latches that are defective
- Tires that have cuts in the sidewall that penetrate to the cord
- Tires that have a tread depth of $\frac{4}{32}$ " or less on any steering axle at any two adjacent major tread grooves anywhere on the tire
- Tires that have a tread depth of $\frac{2}{32}$ " or less on any non-steering axle at any two adjacent major tread grooves anywhere on the tire
- Any tire that is flat or has a detectable or audible leak
- On dual wheel tires: tires that are touching sidewall to sidewall when properly inflated
- Wheel studs missing or loose wheel lugs
- Wheels that are cracked, bent, and/or broken that affect drivability
- An axle with a hub seal that has any Class 3 leakage or an empty reservoir
- Fuel cap is missing or does not seal to prevent spillage



OPERATIONAL CHECK

- Circle Check
- Remove Wheel Chocks, Charging Cords
- Transmission In Neutral / Park
- Parking brake engaged
- Batteries & Ignition on / Allow Gauge Sweep
- Start Motor
- Check Gauges
- View DOT and warning lights
- Air Brake Check



OOS CRITERIA – OPERATIONAL CHECK

- Braking operation that is ineffective
- Parking brake operation that is ineffective
- Insufficient DOT lighting to clearly mark the vehicle
- Insufficient warning lighting to clearly indicate emergency response
- Turn-signal is Inoperable
- Air compressor that fails to build air pressure. The time to build air pressure from 50 psi to 90 psi should not exceed 3 minutes
- Air compressor that fails to maintain 80–90 psi pressure in the system with the service brakes applied and the engine at idle, or air compressor that fails to fill the air system to the air compressor governor cutout pressure with the service and parking brakes released
 - The cut-out pressure should be <135 psi
 - The cut-in pressure should be >80 psi



SHUTTING DOWN APPARATUS

- A hot engine should be allowed to idle for a couple of minutes prior to shut down, i.e. following a response
- Engine and turbo temperatures increase upon shutdown since oil and air are no longer circulating
- Results in damage over time to internal engine components and turbo seals

EMISSIONS REDUCTION SYSTEMS



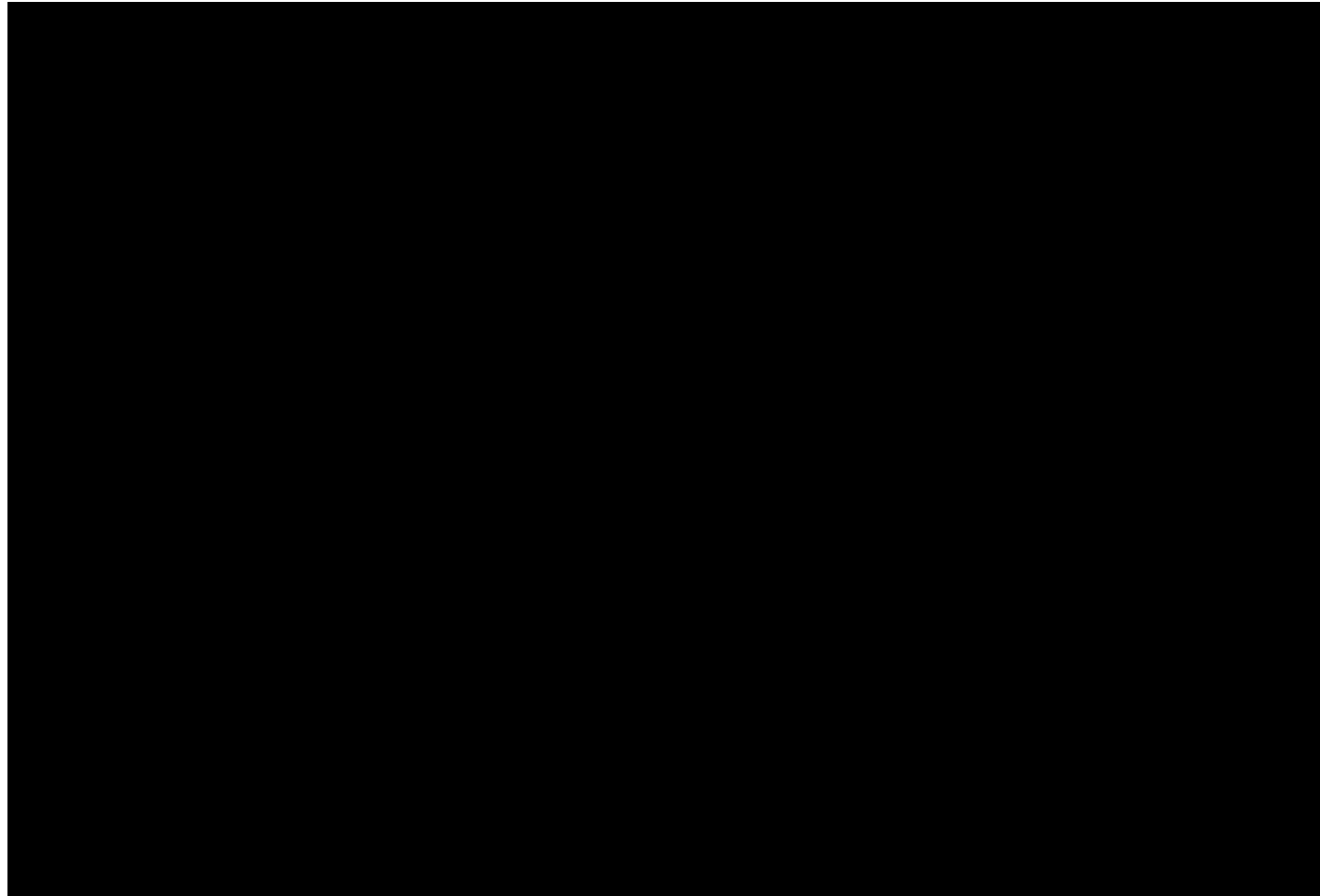


ENGINE AFTERTREATMENT

- Enables compliance with EPA emissions standards – emergency vehicles are NOT exempt
- After 2006, all diesel exhaust systems have a particulate filter and associated regeneration system
 - Diesel Particulate Filter (DPF) captures soot and ash
 - Regeneration burns off the soot and ash that accumulates
- After 2009, aftertreatment systems include Diesel Exhaust Fluid (DEF) for additional treatment of exhaust gases
- There are two operator interventions necessary with these systems:
 - Active Regeneration – aka “parked” regeneration
 - Refilling the DEF tank

DIESEL PARTICULATE FILTER

HOW DOES IT WORK?



DIESEL PARTICULATE FILTER INDICATOR LAMPS



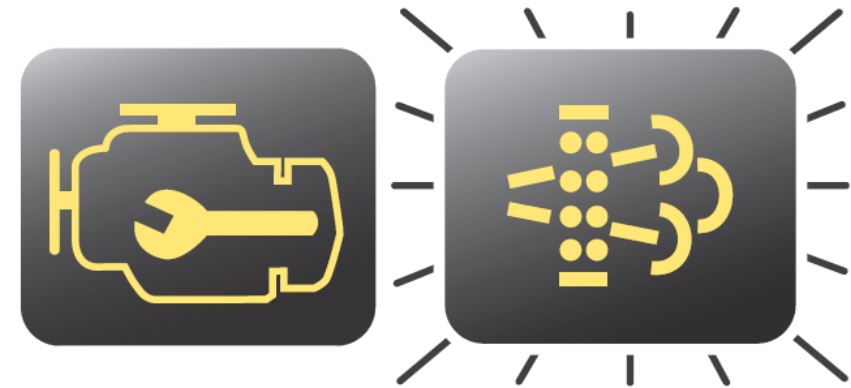
Aftertreatment Diesel Particulate Filter

- Indicates a regeneration is needed – passive or active
- When flashing, regeneration is more urgently needed



High Exhaust System Temperature

- Does not signify any need for service – regeneration occurs at high temperatures
- Keep the exhaust pipe outlet away from combustibles



Flashing DPF Light + Check Engine

- Regeneration is needed immediately
- Active regeneration is required



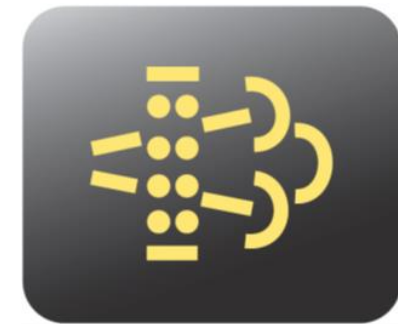
DIESEL PARTICULATE FILTER PASSIVE REGENERATION

- Occurs automatically as needed when driving over 40mph
 - Does not require any action on the part of the driver
- It is unlikely that MCFRS apparatus will drive enough highway miles for Passive Regeneration to complete it's cycle

DIESEL PARTICULATE FILTER

ACTIVE REGENERATION – “PARKED REGEN”

1. DPF lamp illuminates or flashes
2. Determine a suitable location to park the apparatus
 - Away from combustibles or items that could be damaged by exhaust heat – need at least 5 feet of clearance
 - Outdoors and NOT connected to the PlymoVent
3. After parking the unit, engage the manual regeneration
 - May be a toggle switch, rocker switch, or other control
 - Motor rpm should increase to approximately 1100rpm.
4. The driver must remain with the vehicle during regeneration
 - Duration varies by amount of soot in the DPF – 5 to 20 minutes



DIESEL PARTICULATE FILTER

ACTIVE REGENERATION – “PARKED REGEN”

- Regeneration will stop:
 - Automatically when the motor controls sense the particulate filter is cleaned
 - Manually if the brake pedal is depressed
- Unit may remain in service during regen
- Regen will not engage when other vehicle functions are in use, i.e. pump, PTO, hydraulics
- Vehicle exhaust components will remain very hot following the regen process
 - High temperature light will illuminate



DIESEL PARTICULATE FILTER ACTIVE REGENERATION – “PARKED REGEN”



Example of active regen controls



DIESEL EXHAUST FLUID (DEF)

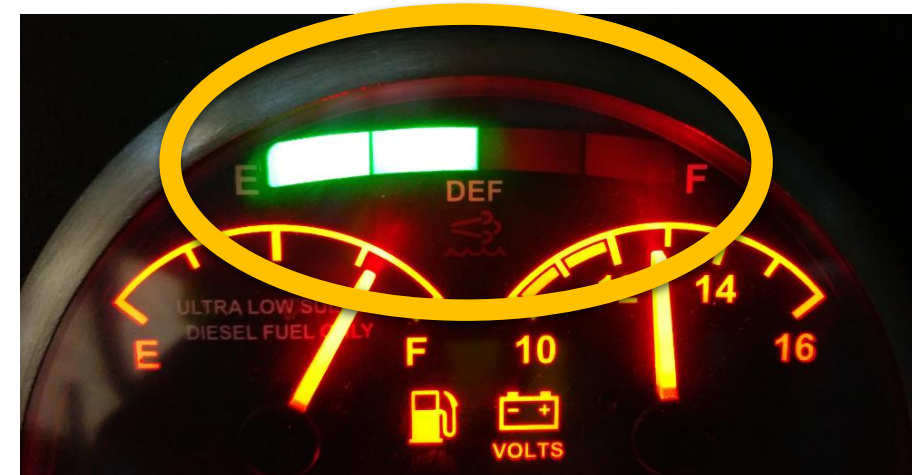
WHAT IS IT & WHAT DOES IT DO?

- Non-hazardous solution of 32.5% urea and 67.5% de-ionized water used in post-2009 diesel vehicles
- DEF is sprayed into the exhaust stream of diesel vehicles to break down NOx emissions into nitrogen and water
- DEF is **not a fuel additive** and never comes into contact with diesel
- DEF is stored in a separate tank, typically with a blue filler cap.

DIESEL EXHAUST FLUID LEVELS & LOCATION



DEF Tank located rear of the batteries
on the driver's side of the unit.



DEF Tank gauge located
above fuel gauge on dash.



DIESEL EXHAUST FLUID CONTAMINATION – FUEL vs. DEF

- Nozzle sizes
 - DEF nozzles are 0.75"; diesel nozzles are 0.87"
 - The diesel nozzle should not fit into the DEF tank
 - The cap for the DEF tank is blue and will be clearly marked
- Diesel in the DEF tank
 - Diesel will float on top of DEF
 - Small amounts of diesel can damage the exhaust system
 - If any fluid except DEF is poured into the DEF tank, contact CMF immediately and do not drive the vehicle.
- DEF in the fuel tank
 - The motor will stop running almost immediately, and the vehicle will require repair



DIESEL EXHAUST FLUID SUPPLY, HANDLING, AND REFILL

- Stocked in 2.5 gallon containers with filler tubes or in bulk at select stations
 - requested as needed through normal supply procedures
- DEF crystallizes when stored for prolonged periods as the water evaporates
 - Do not use DEF that shows signs of crystallization
 - Always completely use a container to avoid storing opened containers
- Refill when the level indicator reaches 1/2 or less
 - The tank should accept one full 2.5 gallon container of DEF
 - No need to continuously top off the DEF tank
- Filler tube is supplied with the case
- Spills can be safely washed down with water. DEF is not corrosive to human skin, however is corrosive to aluminum. Do not allow it to remain on the diamond tread.
- The freezing point of DEF is 12°F, however vehicles are equipped to thaw the DEF and this should not restrict use of the vehicle.
- Personal protective equipment is not necessary when handling DEF, however it will stain clothes.

DEFECT REPORTING





DEFECT REPORTING

FLEET MANAGEMENT REPORTING SYSTEM

- Requires employee ID # and password
 - Not the same as single sign-in or network info
- Statistics are required to complete the online report
 - Vehicle mileage
 - Engine Hours
 - Pump Hours
 - Generator Hours
- Enter only one defect per report
 - Provide a detailed description of the issue
 - Include photos when applicable
- Permits the operator to see what defects exist and who reported them when

MCFRS QUICKLINKS (intended for internal use only)

— Operations Division

• Daily Tools

- [Activity Request](#)
- [DOC Shift Log](#)
- [Daily Battalion Line-Up](#)
- [Webstaff](#)
- [Fleet Apparatus Tracker](#)
- [Defect Entry \(Apparatus, Facilities, THEA, PT equipment\)](#)
- [SharePoint](#)
- [Op's Guidelines and Forms](#)

[Click to go to Defect Reporting](#)



ADDITIONAL RESOURCES

- MCFRS Operator's Guide to Fire Apparatus Out of Service Criteria
 - <http://www.montgomerycountymd.gov/frs-ql/resources/files/apparatus/MCFRSOOSCriteria12.pdf>
- PSTA Driver Training Website
- MCFRS Apparatus Checkout Form
 - <http://www.montgomerycountymd.gov/frs-ql/resources/files/apparatus/checkout/ApparatusCheckout.pdf>
- Pre-trip Inspection Self-Study Guide
 - <https://www.montgomerycountymd.gov/mcfrs-psta/Resources/Files/Driver/class%20materials/EVOC/Summer%202019%20update/Pre-Trip%20Study%20Guide.pdf>

QUESTIONS?

End of Session 2

